PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P200101148 WO	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/EP 03/01945	International filing date *(day/month/year)* 26.02.2003	Priority date *(day/month/year)* 07.03.2002

International Patent Classification (IPC) or both national classification and IPC H04L27/34, H04L27/34

Applicant TELEFONAKTIEBOLAGET L M ERICSSON (PUBL) et al

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 9 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of   sheets.

3. This report contains indications relating to the following items:

   I   ☒ Basis of the opinion
   II   ☐ Priority
   III   ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   IV   ☐ Lack of unity of invention
   V   ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   VI   ☐ Certain documents cited
   VII   ☐ Certain defects in the international application
   VIII ☐ Certain observations on the international application

Date of submission of the demand 08.09.2003	Date of completion of this report 25.05.2004
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Form PCT/IPEA/409 (Cover Sheet) (January 2004)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP 03/01945

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)):*

   Description, Pages

   1-21   as originally filed

   Claims, Numbers

   1-30   as originally filed

   Drawings, Sheets

   1/6-6/6   as originally filed

2. With regard to the **language,** all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description,   pages:

   ☐ the claims,   Nos.:

   ☐ the drawings,   sheets:

5. ☐   This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2- 5, 10, 16-19, 23
	No:	Claims	1, 6-9, 11-15, 20-22, 24-30
Inventive step (IS)	Yes:	Claims	3, 17
	No:	Claims	2, 4, 5, 10, 16, 18, 19, 23
Industrial applicability (IA)	Yes:	Claims	1-30
	No:	Claims	

2. Citations and explanations

   see separate sheet

V.   **Reasoned Statement under Rule 66.2(a)(ii) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

Reference is made to the following document(s):

D1:   DE 199 12 825 C (SIEMENS AG) 10 August 2000 (2000-08-10)

D2:   HELLSTERN G: 'CODED MODULATION WITH FEEDBACK DECODING TRELLIS CODES' PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON COMMUNICATIONS (ICC). GENEVA, MAY 23 - 26, 1993, NEW YORK, IEEE, US, vol. 2, 23 May 1993 (1993-05-23), pages 1071-1075, XP000371241 ISBN: 0-7803-0950-2

D3:   US-A-5 657 354 (THESLING III WILLIAM H ET AL) 12 August 1997 (1997-08-12)

D4:   SPETH M ET AL: 'LOW COMPLEXITY SPACE-FREQUENCY MLSE FOR MULTI-USERF COFDM' 1999 IEEE GLOBAL TELECOMMUNICATIONS CONFERENCE. GLOBECOM'99. SEAMLESS INTERCONNECTION FOR UNIVERSAL SERVICES. RIO DE JANEIRO, BRAZIL, DEC. 5-9, 1999, IEEE GLOBAL TELECOMMUNICATIONS CONFERENCE, NEW YORK, NY: IEEE, US, vol. 5, 5 December 1999 (1999-12-05), pages 2395-2399, XP000958550 ISBN: 0-7803-5797-3

D5:   FAGERVIK K ET AL: 'Low complexity bit by bit soft output demodulator' ELECTRONICS LETTERS, IEE STEVENAGE, GB, vol. 32, no. 11, 23 May 1996 (1996-05-23), pages 985-987, XP006005177 ISSN: 0013-5194

D6:   WO 00 44141 A (ERICSSON INC) 27 July 2000 (2000-07-27)

V-I

1.   Independent method claim 1 does not meet the requirement following from Article 6 PCT taken in combination with Rule 6.3(b) PCT, that any independent claim must contain all the technical features essential to the invention.

The wording of the claim fails to define *which distance* is used in the distance function (page 22, lines 11-13). In view of the description (see page 12 to 16, especially equ. (5) and page 16, 2nd paragraph), it seems that the calculation of the reliability value as a *function of the distances* <u>between</u> *the first and. the second*

symbol and the received signal indeed represents an essential feature to carry out the invention. This technical feature is not presented as optional anywhere in the description. Moreover, the calculation of the reliability value as a function of these distances is in fact the only solution, which is presented in the application for calculation of the reliability values based on the first and the second symbol.

It is emphasised however that these features, although essential to clearly define the claimed subject-matter, do not in themselves result in subject-matter involving an inventive step.

2.   The independent method Claim 1 does not meet the requirements of Article 6 PCT since its subject-matter is not clear for the following reasons:

1.   The wording "generating a reliability value ($L_{k,m}$) *for* a received multilevel signal (r)" (line 4) is inconsistent with and not supported by the description. The received multilevel signal represents a measurement value, the probability of the received value after reception/measurement is equal to one. Consequently, it is not clear, how a useful reliability value *for* the measured multilevel signal can be generated, in particular as the whole application does not provide any information of how this should be done.

On the other hand, as shown e.g. in Fig. 2, each of the transmitted symbols is determined by a certain combination of the bits. The general problem to be solved by a receiver of a multilevel signal is to estimate the transmitted bits *from* the received signal. The whole application is directed to the generation of reliability values *for* these bits *from* a received multilevel signal, see for example page 12, line 8-9: "a soft-value is calculated *for* each bit of every 16QAM symbol" (see also page 16, line 21-23).

2.   Since the technical features of "information" can not be defined, the term "likelihood information" (line 7) is an undefined technical expression and thus unclear. A well known expression in the area of modulation or channel coding, is "likelihood ratio" as supported on page 3, line 33 of the description, or just "likelihood". Furthermore, the wording "likelihood information of receiving said multilevel signal" gives the impression that the received multilevel signal contains some "likelihood information" transmitted from the transmitter, which is not supported by the description, since the whole application is directed to *calculation* of likelihood or reliability values from the received signal (compare item a).

Moreover, the vague wording in line 6-7 leaves the reader in doubt to which

likelihood it is being referred to, the likelihood of the first bit or to the likelihood of any other physical value associated with the received signal, e.g. the phase or the noise vector.

3.   The present wording of the claim "*receiving* said multilevel signal" (line 7) is not clear, since in line 3 the "*received* multilevel" signal has already been introduced.

4.   The wording in lines 13-16 is unclear, as it is not understood what is meant with "the first signal symbol of the signal symbols corresponding to a different binary value ... than the first signal symbol". How can the first signal symbol have a different binary value than the one which it has?

3.   The same objections as in paragraphs 1 and 2 apply equally to claim 15 which is thus not allowable for lack of essential features (Article 6 PCT and Rule 6.3(b) PCT) and for lack of clarity (Article 6 PCT).

4.   Moreover, from the wording of claim 15 "An arrangement" it is not clear if protection is sought for a device or a method, since an "arrangement" can refer to "*a group of things* that have been arranged" and also to "*the act* of arranging a group of things" (see e.g. *Longman Dictionary of Contemporary English*, 3rd edition, 1995, Longman Group Ltd, Harlow) (Article 6 PCT).

The same objection equally applies to dependent claims 16-27, and in particular to the method steps described in line 10 of claim 19 ("the predetermined constant *is selected* ... ").

5.   Concerning the dependent claims, the following objections with respect to Article 6 PCT are raised:

1.   With respect to claim 4, from the wording it is not clear if the polynomial function or the second distance is multiplied with the predetermined constant (K). However, in view of the description (see equ. (7) on page 14 or page 19, line 7), it is the polynomial function which is multiplied with K.

The same objection equally applies to claim 18.

2.   With respect to claim 9, from the wording "identified by means of a *slicer*" it is not clear which function is actually carried out. The term "slicer" does not unambiguously define which function is carried out by that device. In other words, it is unclear whether the first signal symbol in claim 9 is effectively identified by a slicing step of by other, yet undefined method steps carried out by the slicer. Furthermore it is not defined *what* is sliced in order to achieve

identification of said first symbol.

3.   For the same reason as set out above with respect to the expression "likelihood information" in item 2b, the wording of claims 10 and 23 is not clear.

V-II

1.   The subject-matter of present claim 1 is already known from prior art document D1, which discloses according to the features of claim 1 (the corresponding features in D1 are given in brackets):

A method of generating a reliability value for a received multilevel signal in relation to a number of predetermined signal symbols each associated with a corresponding bit sequence including a first bit position [page 2, line 65-67: "wird für jedes in dem empfangenen Datensymbol enthaltende Informationselement eine Zuverlässigkeitsinformation ... ermittelt"];

the method comprises the steps of

-    identifying a first one of the number of signal symbols as being closest to the received multilevel signal [page 5, lines 12-13: "Das empfangene Datensymbol sym wird dem Konstellationspunkt cpc mit der geringsten euklidischen Distanz dc zugeordnet"] ; and

-    estimating the reliability value based on a stored precomputed distance function [it is implicit to a skilled person that the equations (1)-(3) or (4)-(6) on page 5 are stored in the receiver, since otherwise the receiver does not work. The equations (4)-(6) are intermediate "precomputed" distance functions] of at least a first signal symbol [see Fig. 6: symbol "cpc"] and a second one of the number of signal symbols [see Fig. 6: eg. symbol "cpi"],

-    where the second signal symbol is the signal symbol closest to the first signal symbol of the signal symbols corresponding to a different binary value at the first bit position of the respective associated bit sequence than the first signal symbol [page 5, lines 13-20: "Anschliessend werden abhängig von dem zugeordneten Konstellationspunkt cpc weitere Konstellationspunkte cpi, cpj, cpk ermittelt, die eine jeweilige Änderung der Zustände der Informationselemente bit1, bit2, bit3 bewirken. ... wobei der die Änderung verursachende weitere Konstellationspunkt mit der geringsten euklidischen Distanz di zu dem Datensymbol sym gewählt wird." Remark: The second symbol cpi in Fig. 6 is the

symbol with opposite first binary value, which is closest to sym and which is also closest to the first symbol cpc. It is clear, that for the symbol constellation shown in Fig. 6, the second symbol cpi is for all received values sym equal to the symbol of opposite binary value, which is not only closest to sym, but also closest to the first symbol cpc].

Therefore the subject-matter of claim 1 is not novel and hence claim 1 does not meet the requirements of Article 33(2) PCT.

Furthermore, even if the applicant were to interpret the claim in such a manner as to enable him to allege that its subject-matter were novel, based on a trivial difference, the subject-matter would still not involve an inventive step in the light of documents D1 (Article 33(3) PCT).

2. The same objections as set out above in item 1 equally apply to the subject-matter of claim 15 which corresponds to that of claim 1 in terms of apparatus features. Therefore the subject-matter of claim 15 is not novel (Article 33(2) PCT), or at least does not involve an inventive step (Article 33(3) PCT).

3. The dependent claims do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT with respect to novelty and/or inventive step:

1. Claims 2, 16: cf. D1, Fig. 7: for each symbol and bit position the corresponding symbol with smallest distance is stored. To store the corresponding function (with the appropriate sign value, see equ. (4)-(7)) instead of the corresponding symbol in order to calculate the reliability value is straight forward. ·

2. Claims 4 and 18: Selection of polynomial function with constant factor is disclosed in D2, equ. (6) (the factor is $1/N_0$)

3. Claims 5 and 19: cf. D2, equ. (6).

4. Claims 6 and 20: cf. D1, equ. (1)-(6) are in fact approximations of the reliability values.

5. Claims 7 and 21: cf. D1, Fig. 7.

6. Claims 8 and 29: cf. D1, page 4, lines 11-12.

7. Claims 9 and 22: cf. D1, Fig. 5 and page 4, line 53-55 "Entscheidungsflächen".

8. Claims 10 and 23: cf. D2, equ. (6).

9. Claims 11 and 24: cf. D1 page 5, lines 12-20.

10.   Claims 12 and 25: cf. D1 page 2, line 57 "In-Phase und ... Quadratur-Komponente".

11.   Claims 13 and 26: cf. D1, page 5, lines 59-60.

12.   Claims 14 and 27: Gray mapping is well know and also used in D1, see Fig. 6.

13.   Claim 28: cf. D1, claim 11.

14.   Claim 30: cf. D1, page 2, line 21-24: "GSM-Mobilfunksystem".

4.   The Applicant's attention is however drawn to the fact that the documents in the International Search Report do not seem to suggest a determination of the reliability value as a function of the distances δ_1 and δ_3 (see Fig. 2 and 5), where δ_3 is being used as an approximation for δ_2.

V-III

Certain defects in the international application

When entering the national or regional phase, the following points should also be taken into account:

1.   The requirements of Rule 5.1(a)(ii) PCT are not met, since the closest prior-art document D1 is not identified in the description and the relevant background art disclosed therein is not briefly discussed.

2.   Furthermore, following the disclosure of document D1, the statement indicating the technical problem to be solved by the invention, requires revision, which should be effected taking the requirements of Rule 5.1(a)(iii) PCT into account.